GRADED APPLICATION OF SYSTEMS ENGINEERING

The following matrix, presents a graded approach to applying the Systems Engineering process and developing SE products. This approach is designed to give Program Managers and supporting Systems Engineers direction as to the level of detail required to meet the guidelines of PRD-181 (Systems Engineering) and to satisfy the needs of a specific customer or project.

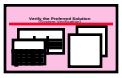
- ***Level 3*** utilizes high-level review of a particular problem and is tailored for those activities that must be done in an extremely short time frame or with a very small budget. As such, the products listed are created by completing pre-designed forms that represent a subjective record of the steps followed to reach a solution. A Project Manager (PM) should be able to use these forms and perform the necessary actions at this level.

- ***Level 2*** builds on Level 3 and is targeted at more complex efforts that require control of all documents and products generated. This level, however, does not require formal, documented reviews and baselines, but does control and track all data and decisions generated. Sufficient documentation is generated to provide objective, traceable and justifiable results. At this level, the PM is usually assisted by full or part time use of practicing Systems Engineers.

- ***Level 1*** extends the bounds of Levels 3 and 2 to include formal reviews, rigorous configuration management, and detailed system baselines. This extensive SE approach is targeted at those large-scale, complex programs that "must be right the first time." For this comprehensive application, The PM typically employs a small group of dedicated Systems Engineers.

After identifying appropriate level(s) of SE products, the Systems Engineers and Program/Project Managers then complete the checklist on the following pages and identify the specific SE products to be generated and used. In addition, responsibilities for producing these products are assigned in the boxes indicated.

(The following responsibility abbreviations are used on the next two sheets: **N/A**–Not Applicable; **PM**–Program Manager; **SE**–Systems Engineer; **PC**–Project Controller; and **TS**–Technical Specialist.)

Project Structures / SE Process Phases	Level 3: (least rigorous) Size: <5 people Complexity: Low Duration: <1 year Risk: Little to None Funding: < $500K	Level 2: Size: 5 to 50 people Complexity: Medium Duration: 1 to 2 years Risk: Moderate Funding: $500K to $2M	Level 1: (most rigorous) Size: >50 people Complexity: High Duration: >2 years Risk: Considerable Funding: > $2M
	System Boundaries Driving Requirements SE Checklist	System Engineering Management Plan (SEMP) Document Control Log	Risk Mitigation Plans Verification Plans
	Customer Needs Statement Technical Performance Measures Initial System Hierarchy	Measurable Parameters System Requirements Document Technical Baseline Revision 0	System Requirements Review
	Document Control Log	Configuration Management Plan Change Control Procedures	Change Control Board Configuration Status Accounting
	System Functional Architecture Initial System Interfaces	Formalized Functional Hierarchy Technical Baseline Revision 1 System States and Modes	Detailed System Specifications
	Decision Criteria ("System has to ...")	Trade Study Design	Detailed Solution Selection Criteria
	Alternative System Concepts Preferred System Solution	Alternative Trade Studies Physical System Architecture Cost and Schedule Baselines	Conceptual Design Review
	Modified System Boundaries Negotiated Interfaces	Interface Control Documents System Description Document	System Design Review
	Informal Verification against Requirements	Formal Verification Plans/Activities Verification Discrepancies/Resolutions	System Readiness Review

SE Products are Cumulative as Complexity Increases

SYSTEMS ENGINEERING CHECKLIST

SYSTEM PLANNING & INTEGRATION

			❑3 ❑2 ❑1
· Identify top-level driving requirements and establish preliminary system boundaries to aid in planning.	System Boundaries and Driving Requirements	❑ ❑ ❑ ❑ ❑ N/A PM SE PC TS	____/____ PM SE
· Determine level(s) of SE application and identify required SE products.	Systems Engineering Checklist	❑ ❑ ❑ ❑ ❑ N/A PM SE PC TS	____/____ PM SE
· Define and document how systems engineering processes will be used	Systems Engineering Management Plan	❑ ❑ ❑ ❑ ❑ N/A PM SE PC TS	____/____ PM SE
· Track system documentation	Document Control Log	❑ ❑ ❑ ❑ ❑ N/A PM SE PC TS	____/____ PM SE
· Ensure that potential risks are identified and assessed for mission impact, and that mitigation plans are developed and implemented	Risk Mitigation Plans	❑ ❑ ❑ ❑ ❑ N/A PM SE PC TS	____/____ PM SE
· Ensure that initial verification needs are identified and documented	Verification Plans	❑ ❑ ❑ ❑ ❑ N/A PM SE PC TS	____/____ PM SE
· Formally document planned configuration management/change control activities.	Configuration Management Plan	❑ ❑ ❑ ❑ ❑ N/A PM SE PC TS	____/____ PM SE
· Revisit system boundaries and modify them, as necessary, to facilitate the preferred system solution.	Modified System Boundaries	❑ ❑ ❑ ❑ ❑ N/A PM SE PC TS	____/____ PM SE
· Conduct and document Technical Reviews throughout the program life-cycle	System Design Review	❑ ❑ ❑ ❑ ❑ N/A PM SE PC TS	____/____ PM SE

MISSION ANALYSIS

			❑3 ❑2 ❑1
· Formulate a clear mission statement of the problem being addressed.	Mission Statement	❑ ❑ ❑ ❑ ❑ N/A PM SE PC TS	____/____ PM SE
· Quickly document what the customer(s) want and any reasoning behind each requirement.	Customer Needs Statement	❑ ❑ ❑ ❑ ❑ N/A PM SE PC TS	____/____ PM SE
· Define the Technical Performance Measures (TPMs).	Technical Performance Measures	❑ ❑ ❑ ❑ ❑ N/A PM SE PC TS	____/____ PM SE
· Revisit preliminary system boundaries and establish a "System of Systems" hierarchy based on identified customer needs.	Initial System Hierarchy (System of Systems)	❑ ❑ ❑ ❑ ❑ N/A PM SE PC TS	____/____ PM SE
· Define the system under consideration and the boundaries between it and other related systems.	System Boundary Description	❑ ❑ ❑ ❑ ❑ N/A PM SE PC TS	____/____ PM SE
· Identify initial high level requirements set, should include expectations, requirement, issues,	Customer Requirements Document	❑ ❑ ❑ ❑ ❑ N/A PM SE PC TS	____/____

constraints, assumptions, and assertions.	PM	SE

REQUIREMENTS ANALYSIS AND BASELINING			❑3 ❑2 ❑1
· Identify system customers and stakeholders.	Customer Set	❑ N/A ❑ PM ❑ SE ❑ PC ❑ TS	_____/_____ PM SE
· Formulate a clear statement of the problem being addressed and establish/document mission objectives and program/project requirements	System Requirements Document (Technical Baseline Revision 0)	❑ N/A ❑ PM ❑ SE ❑ PC ❑ TS	_____/_____ PM SE
· Identify measurable parameters (i.e., quantifiable, verifiable) for each system requirement.	Measurable Parameters	❑ N/A ❑ PM ❑ SE ❑ PC ❑ TS	_____/_____ PM SE
· Conduct and document Technical Reviews throughout the program life-cycle	System Requirements Review	❑ N/A ❑ PM ❑ SE ❑ PC ❑ TS	_____/_____ PM SE
· Develop the System Specification consisting of derived requirements that govern implementation.	Systems Specification	❑ N/A ❑ PM ❑ SE ❑ PC ❑ TS	_____/_____ PM SE
BASELINE MANAGEMENT AND CHANGE CONTROL			❑3 ❑2 ❑1
· Establish formal change control procedures, including standard change request forms, etc.	Change Control Procedures	❑ N/A ❑ PM ❑ SE ❑ PC ❑ TS	_____/_____ PM SE
· Develop and implement process for report status of configuration controlled items.	Configuration Status Accounting	❑ N/A ❑ PM ❑ SE ❑ PC ❑ TS	_____/_____ PM SE
· Implement change control board to review, approve, and implement changes to technical, cost, and schedule baselines.	Change Control Boards	❑ N/A ❑ PM ❑ SE ❑ PC ❑ TS	_____/_____ PM SE
FUNCTIONAL ANALYSIS AND DECOMPOSITION			❑3 ❑2 ❑1
· Conduct Functional Analyses and allocate decomposed system requirements to the appropriate system functions and sub-functions	System Functional Architecture	❑ N/A ❑ PM ❑ SE ❑ PC ❑ TS	_____/_____ PM SE
· Document system functions and allocated requirements.	Formalized Functional Architecture (Technical Baseline Revision 1)	❑ N/A ❑ PM ❑ SE ❑ PC ❑ TS	_____/_____ PM SE
· Identify potential system states and modes and decompose system functions accordingly.	System States and Modes	❑ N/A ❑ PM ❑ SE ❑ PC ❑ TS	_____/_____ PM SE
· Prepare system specifications for each functional component, etc.	Detailed System Specifications	❑ N/A ❑ PM ❑ SE ❑ PC ❑ TS	_____/_____ PM SE
DECISION CRITERIA DEVELOPMENT			❑3 ❑2 ❑1
· Determine critical sub-set of performance, functional, and/or constraining requirements to develop detailed criteria from.	Basis for Decision Criteria	❑ N/A ❑ PM ❑ SE ❑ PC ❑ TS	_____/_____ PM SE

· Define and document Decision Criteria as a basis for evaluating alternatives.	Decision Criteria	❑ ❑ ❑ ❑ ❑ N/A PM SE PC TS	_____/_____ PM SE
· Identify and document formal solution selection criteria to aid in decision making.	Detailed Solution Selection Criteria	❑ ❑ ❑ ❑ ❑ N/A PM SE PC TS	_____/_____ PM SE
· Define Weight Factors for each decision criteria.	Weighting factors	❑ ❑ ❑ ❑ ❑ N/A PM SE PC TS	_____/_____ PM SE

ALTERNATIVES ANALYSIS AND SYSTEM SYNTHESIS			❑3 ❑2 ❑1
· Assist in the development and documentation of alternative concepts that meet system requirements; ensure that features for the optimum life-cycle and operating efficiency are considered and incorporated into the alternative concepts	Alternative Systems Concepts	❑ N/A ❑ PM ❑ SE ❑ PC ❑ TS	_____/_____ PM SE
· Compare Alternative Concepts to the "System Must Do ..." list and score each concept against each item.	Alternatives vs. System Requirements Checklist	❑ N/A ❑ PM ❑ SE ❑ PC ❑ TS	_____/_____ PM SE
· Perform sensitivity and trade analyses to determine the most cost-effect/best performance alternative and document the results as a basis for informed decision making	Trade Studies/Analyses Plans and Reports	❑ N/A ❑ PM ❑ SE ❑ PC ❑ TS	_____/_____ PM SE
· Develop and document Detailed Designs and Related Performance Data for the preferred system solution.	Preferred System Solution	❑ N/A ❑ PM ❑ SE ❑ PC ❑ TS	_____/_____ PM SE
· Update Technical Baseline to include the Physical System Architecture of the preferred solution	Physical System Architecture (Technical Baseline Revision 2)	❑ N/A ❑ PM ❑ SE ❑ PC ❑ TS	_____/_____ PM SE
· Establish cost and schedule baseline for the preferred system solution.	Cost and Schedule Baselines	❑ N/A ❑ PM ❑ SE ❑ PC ❑ TS	_____/_____ PM SE
· Conduct and document Technical Reviews throughout the program life-cycle	Conceptual Design Review	❑ N/A ❑ PM ❑ SE ❑ PC ❑ TS	_____/_____ PM SE
SYSTEM INTEGRATION AND INTERFACE CONTROL			❑3 ❑2 ❑1
· Negotiate interface agreements both internal and external to the preferred system.	Negotiated Interfaces	❑ N/A ❑ PM ❑ SE ❑ PC ❑ TS	_____/_____ PM SE
· Document all interface descriptions, owners, negotiated interface relationships, and interface data in Interface Control Documents (ICDs).	Interface Control Documents	❑ N/A ❑ PM ❑ SE ❑ PC ❑ TS	_____/_____ PM SE
· Prepare Formal System Description Document to include System Requirements, Functional Architecture, Physical Architecture, and System Interfaces.	System Description Document (Technical Baseline Revision 3)	❑ N/A ❑ PM ❑ SE ❑ PC ❑ TS	_____/_____ PM SE
· Conduct a System Design Review.	System Design Review	❑ N/A ❑ PM ❑ SE ❑ PC ❑ TS	_____/_____ PM SE
SYSTEM VERIFICATION			❑3 ❑2 ❑1
· Check the Preferred Alternative against the original Systems Requirements list to make certain all requirements have been met.	Informal Verification Against Requirements	❑ N/A ❑ PM ❑ SE ❑ PC ❑ TS	_____/_____ PM SE
· Develop and implement Formal Verification Plans	Formal Verification	❑ ❑ ❑ ❑ ❑	_____/_____

and Activities	Plans and Activities	N/A PM SE PC TS	PM SE
· Identify and resolve any discrepancies between system requirements and actual system.	Verification Discrepancies and Resolutions	❑ ❑ ❑ ❑ ❑ N/A PM SE PC TS	_____/_____ PM SE
· Conduct and document Technical Reviews throughout the program life-cycle	System Readiness Review	❑ ❑ ❑ ❑ ❑ N/A PM SE PC TS	_____/_____ PM SE

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